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CHEMISTRY: ANCIENT AND MODERN.

Some Fundamental Problems in Chemistry—Old and New. By Prof. E. A. Letts. Pp. xiii + 235 + plates. (London: Constable and Co., Ltd.) Price 7*s*. 6*d*. net.

THOSE chemists whose memories can carry them back for a period of about half a century will have experienced several phases in the development of the science which, at their respective periods, were regarded as marking a transition from an older to a newer chemistry. The writer of this notice began his reading when water was HO and so forth. Then came the "new notation" resulting from the proper recognition of Avogadro's law, the doubling of certain atomic weights, and the reconstruction of our formulæ. This was the "new chemistry" of that period. Next arose the more complete elaboration of the conception of constitution or structure based on valency, due to Frankland and Kekulé, and we had a yet newer chemistry—a development which was so extraordinarily prolific in the way of results that chemists were inclined to hug themselves into the belief that they had come to close quarters with the inner mechanism of molecular structure, and the very weaknesses of the theory, which had shown signs of breaking down in certain directions, afterwards became cornerstones of strength in the light of the brilliant hypothesis of van't Hoff and Le Bel, which inaugurated the then new science of stereochemistry. Moreover, about the same period when structural chemistry was undergoing these developments, attention was being more systematically concentrated upon the relationships of the chemical elements among themselves, these studies culminating in that periodic classification associated with the names of Newlands, Mendeléeff, and Lothar Meyer. From that great generalisation arose a still newer chemistry which systematised the whole treatment of the science, both theoretically and practically, and dominates our present teaching. Another "new" chemistry must be added to this record—the application of purely physical methods to the study of chemical phenomena resulting in the foundation of "physical chemistry" as a distinct subject.

All these phases are familiar to the modern student of the history of the science, and they fall into the category of what the author of the present work would term the older chemistry. Dr. Letts does not, however, deal with all these developmental epochs; the older chemistry—as distinguished from ancient chemistry—is limited by him to the discussion of the methods and results of atomic weight determinations by the older as well as by the most recent workers in this field, and to a very full consideration of the periodic law and its consequences. The reader will find no reference to those fundamental problems relating to chemical statics and dynamics which the physical chemists have formulated as the results of their studies; such familiar terms as mass action, osmotic pressure, electrolytic or ionic dissociation, stereochemistry, etc., do not appear in the index. This criticism amounts simply to the statement that the author professes to deal only with certain of the fundamental problems, and within the limits thus assigned, he handles his subject in a very lucid and suggestive way. His treatment of the periodic law, for example, to which two chapters are devoted, goes far beyond the arid description found in the ordinary text-books and may be commended as worthy of most serious consideration by all students. Workers on the look-out for new elements may take courage from Dr. Letts's suggested classifications, according to which there remain either thirty-eight or twenty-five gaps in the periodic table now waiting to be filled up (p. 60). Another valuable feature of this section is the new "atomic volume" curve, constructed by the author from the most recent available data, and, for the first time, comprising the group of "inert" elements. As will be seen on reference to the original work, this curve differs in some important particulars from that first given to our science by Lothar Meyer in 1870, and opens up some interesting suggestions with respect to missing elements.

Although the older chemistry is treated of in the present work within the limits specified, the reader will gather from the subsequent chapters that these older workers—and happily for our science that generation has not yet become extinct—have passed on to the newer school a very goodly heritage. By the "newer chemistry" Dr. Letts understands that great body of observed facts and theoretical deductions which have been accumulated since the study of the action of the electric discharge upon highly attenuated, gaseous matter was seriously taken in hand by physicists and chemists, and since the discovery of radio-activity and the radio-active elements. How much of this newer knowledge will be passed on as canonical to future generations it would be very rash to predict. It is, however, certain that chemistry, by the discovery of unexpected phenomena, and by the utilisation of novel methods of attacking the ultimate components of matter, has now entered upon a new era in its history—a state of affairs which both students and teachers, whether of the older or newer school, must perforce take into consideration.

From this last point of view the present work presents certain special advantages which may be summed up by the statement that the author handles his subject as a chemist. The day has passed away when workers with parochial views of their science can hope to impose upon the present generation stupidly narrow limitations by "method"—to insist that the evidence based upon "purely chemical" methods is alone of weight to chemists, and that the results achieved by "purely physical" methods must be received with suspicion. But for the chemist it certainly is of importance, in view of the bewildering rapidity of the development in this newer domain, to have the results, by whatever method achieved, co-ordinated and fitted in to that older structure with which we were all familiar in the days of our own studentship. Dr. Letts may be congratulated upon having accomplished this task with conspicuous success within the compass of his brief. His historical records, which are fairly given, are as up-to-date as can reasonably be expected, and the descriptive portions are summarised at the end of the chapters with a clearness which shows that the author has a thorough grasp of his subject. Perhaps it may be urged by extreme critics that he is not sufficiently critical—that he appears to accept as established truths and without comment published statements concerning "transmutation," about which there is conflict of evidence. But the present work professes to be but a literary production, and the author, perhaps wisely in the present state of knowledge, simply sets forth the evidence and the suggested interpretations of that evidence. All who have watched the development of this "newer chemistry" have thoroughly realised the extraordinary practical difficulties which confront the experimenter at every stage. The infinitesimal quantities of material which have to be dealt with and the extreme delicacy of the methods of attacking the new problems offered by a subject which is still "in the making" are such as to give much scope for apparently conflicting evidence. The future writer of the history of chemistry will find ample matter for marvel at the results which have even now been achieved in spite of the difficulties referred to. That Dr. Letts is himself appreciative of the skill which has surmounted so many of these obstacles is apparent in many pages of the volume under consideration.

It is now a matter of ancient history that on the discovery of spectrum analysis chemistry and astronomy entered into partnership. But the new chemistry, as understood in the present work, has also widened the horizon of the science to an extent that renders necessary the consideration by chemists of problems of a cosmical order in a much more definite and concrete form than has hitherto been customary. It is obvious that questions concerning the constitution of the atom and the evolution or disintegration of matter cannot be confined within terrestrial limits. On the first of these questions the author has something to say, and in the ninth chapter will be found a succinct account of the electron theory, with reference more especially to the work of J. J. Thomson. Now it is precisely on this question of the present position of the electron theory that chemists are awaiting further light from the physical side. So far, with the exception of Sir William Ramsay's preliminary attempt, this theory cannot be said to have been brought seriously within the domain of practical chemical politics. It is not mere curiosity that prompts the chemist to ask whether the atom is to be regarded as a complex mechanism composed entirely of electrons or whether there may not be other components. Dr. Letts thus answers the question:—

"From spectroscopic and other evidence it would appear to be certain that electrons are universal constituents of atoms, but on the other hand, there appears to be no sufficient evidence for the assumption that electrons are the sole constituents of these atoms. . . . all but about one-thousandth of its mass is associated with the positive part of an atom, which would tend to show that an altogether exaggerated rôle has been attached to the electron in the constitution of matter."

This at any rate was the view held by the writer of the section on radioactivity in the Annual Reports of the Chemical Society in 1906, from whom the author takes his information.

With reference to the other question—the evolution and dissolution of matter—the reader will find in the tenth chapter a good summary of the observations and conclusions of Lockyer, as set forth in his "Inorganic Evolution" and other publications. One result of the "new chemistry" is thus to bring us back to what may be termed the presentation of the case from the astrophysical side. There is distinct evidence of this reactionary influence of the new chemistry upon the pioneering work of Lockyer now to be found in many recent treatises besides the volume under consideration, in which some twenty pages are devoted to the subject. The "disintegration" theory of radio-activity, which now holds the field, has brought into modern chemistry certain very concrete notions concerning what may be defined as down-grade evolution. It is but natural to ask with Dr. Letts (p. 190) whether the reverse or up-grade process of evolution from elements of low atomic weight to elements of higher atomic weight occurs anywhere in the cosmos. If evolution is universally true in principle some process of this order must have occurred in the past and may be occurring now. Laboratory results which are indicative of "transmutation" in the sense of degradation are becoming more and more incorporated with modern chemical doctrine, but experimental evidence of the opposite process can scarcely be considered at present conclusive. The notion of utilising the energy of degradation of radium emanation for transmutational purposes was presumably based on the expectation of degradation rather than of aggregation.

The question of the evolution of the chemical elements is an old one, and the suggestion of evolution offered by the periodic law has been taken up by many writers whose speculations are no doubt familiar to chemists. The author of the present work does not discuss any of these speculative attempts to trace the lines of descent, although he gives some very useful tables summarising existing knowledge with respect to the disintegration products of the radio-active elements. But in directing attention once again to the evidence of evolution furnished by the study of stellar spectra by that comparative method which will always be recognised as the work of Lockyer and his school, Prof. Letts does good service by reminding chemists that the newer developments of their science have enhanced the importance of astrophysical (why not astrochemical?) work to an extent quite undreamt of at the time when the spectroscope was first brought to bear upon these problems.

If any justification for undertaking the part of a critic is required on the present occasion it may be permissible to express regret that the author should have devoted so much space to reprinting long extracts from the original writings of the authorities quoted. All the books and papers referred to are easily accessible, and Dr. Letts gives evidence of being such a very clear thinker when he deals with his subject in his own way that we should much have preferred to read his own version and criticisms. This particularly applies to the last chapter, which is devoted to an account of the views of Arrhenius in his now well-known book on "Worlds in the Making" published in 1908. The direct bearing of the views set forth in that work on the fundamental problems of modern chemistry are not very obvious, and we should have been glad if Dr. Letts could have given less space to the extracts from the said book and more space to the discussion of the special reasons for including the subject in his own volume. The main contribution to purely "astrochemical" thought which must be credited to Arrhenius would appear to be the recognition of heat as an associative as well as a dissociative agency. In theories of cosmical evolution, this point may have been insufficiently realised, although the possibility of endothermic combination between certain elements under high pressure in the sun and stars cannot be generalised into a universal process for all kinds of matter without further evidence.

Enough has been said, however, to warrant the statement that the author has produced a most useful and suggestive little volume which may be profitably read by chemists of both the older and younger generations. R. MELDOLA.

GEOLOGY AND GEOGRAPHY.

(1) *La Face de la Terre.* (Das Antlitz der Erde.) By Prof. Ed. Suess. Traduit de l'Allemand avec l'Autorisation de l'Auteur et Annoté sous la Direction de Emm. de Margerie. Tome 3. (3 Partie.) Pp. xi+957—1360. (Paris: Armand Colin, 1913.) Price 12 francs.

(2) *Traité de Géographie Physique. Climat—Hydrographie—Relief du Sol—Biogéographie.* By Prof. Emm. de Martonne. Deuxième Edition. Pp. xii+922. (Paris: Armand Colin, 1913.) Price 22 francs.

THE two volumes before us strikingly illustrate the principle that scientific geography—as distinct from mere geographical description—must be based on the deductions of geology and the physical sciences; and no less do they indicate how much geology looks to gain from the study of the present features of the earth's surface, and of terrestrial processes now going on upon it.

(1) That M. Margerie's French edition of the great work of the distinguished Austrian geologist is not a mere translation has been already pointed out in the pages of NATURE. The judicious notes, bringing the text up-to-date, with the exhaustive references to recent literature and the numerous additional illustrations, make the book an absolute necessity in every scientific library. In this third part of vol. iii., M. Margerie has reached the penultimate section of his great task, and an additional coloured plate, with eighty new illustrations in the text, give a measure of the important additions which have been made to the original work.

(2) Nor are the additions which have become necessary to the comprehensive volume of Prof. de Martonne less abundant and important. Since the first edition appeared four years ago, the author reminds us that geographical research has added largely to our knowledge—not the least striking